DEPRECIATION

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I

In public valuation for rate-making purposes there is probably more at stake in the problem of so-called depreciation than in any other one element. Yet a clear conception of what depreciation means and how and when it should be applied or omitted as an element in so-called valuations is rare among the engineers, commissions and courts upon whom rests the responsibility of determining the status of hundreds of millions of public service property.

To have a clear conception of the problem it is necessary in the first place to understand clearly in each case just what is meant by the term "value" or "fair value." To say that a property is worth so much money might mean that the sum arrived at is the one which in the judgment of the speaker the property ought to bring or he might mean that the amount stated was the sum which in his judgment it would bring under conditions of sale. In handling the discussion it is probably necessary to limit the meaning of the word "value," when unqualified, to the exchange value in money. In fact when we measure any value in money we must mean an exchange value and if the term value is unqualified it must mean that sum which the property in all likelihood *would* bring at a fair sale.

It should be evident that, in the case of public service properties, the value of the property as a whole means its value as an investment and the controlling factor in the value of an investment is the return upon the investment and the stability of that return. If this is true it must follow that the "present value" of a public service property depends largely upon the present net returns and their stability and that any change in rates or regulation of service which will change the returns will change the present value of the property. Therefore, if as is so often stated by commissions and courts, the object of so-called valuation work is to obtain "present value" the

very statement would prohibit any change in rates or operating expenses affecting the returns.

That there are other elements going to make up the present value of the property besides the net returns may be true but these elements are in fact subsidiary elements to the factor of net returns. If for instance a property is in a bad condition; in determining its present value the important circumstance to the prospective buyer or investor is that he will be deprived of returns upon his investment in order to put the property in condition or he will be obliged to make an added investment to bring it into condition and thus cut his rate of return on the whole capital invested. If we concede as seems necessary that in a rate or service regulation case the present value cannot be obtained unless it is granted that there is to be no change in the rates or expenses of service (which would make the whole work of valuation useless) then the necessary conclusion must be that the object of so-called valuation for rate making or regulation purposes is not to obtain a "present value."

It would seem that the only possible and the only dependable object of valuation work is to obtain what may be called a "just amount" upon which the investor should be allowed to earn reasonable returns. While this amount may or may not closely approximate a present exchange value this circumstance is merely accidental and the two things are fundamentally different in principle.

The history of values as established by our courts shows that, in the era preceding attempts at valuation for rate-making purposes, the principal object in establishing any value was for the purpose of sale under condemnation or for taxing purposes. In either of these cases it is seen that justice is accomplished by comparison; that is, if in the condemnation the owner receives a value comparing with what would be received under free sale for similar property he is justly treated and if the owner is taxed in proper comparison with other owners possessing property of similar exchange value he also will be justly treated, therefore the probable present exchange value of the property was properly the object sought.

The courts, and following them some of the public service commissions, have never been able to clear their minds of this idea of obtaining present exchange value in rate cases. They have of necessity recognized, however, that, in rate cases, the present returns, although the principal factor in determining present value, could not

be taken into consideration. They have, therefore, been forced to take the first step in a correct method of arriving at a "just amount" to be earned on. This step is a so-called valuation of the property by means of an inventory and assignment of unit costs, together with estimates of costs of establishing a going business, etc. It is seen that this step is not directly toward ascertaining present exchange value of the property as a whole but merely arrives at a summation of costs or at the present real investment in the service of the public.

Having ascertained as nearly as possible the full investment or full costs of the present property and organization in the service of the public, in other words having ascertained the money efficiently sacrificed by the investor to serve the public, the courts and commissions have then suffered mental lapse by introducing the question of present exchange value and have tried to arrive at it by saying "this property is not new therefore cannot be *worth* so much as when it was new, therefore we will depreciate it in an attempt to arrive at a present exchange value."

This reasoning attempts to arrive at a present exchange value of the property as a whole, first, by using the factor of costs or investment which in principle has little or nothing to do with present exchange value and second by using the age or condition of the property, which affect present exchange value only in so far as they influence returns. Fortunately in the principal decisions of the higher courts the term used in describing the object of public valuation is "*fair* value," and although what should be its true meaning has been much obscured by the muddled reasoning of the courts, yet it may be interpreted to mean that the result of a valuation will be such as, when a proper rate of return is allowed, will justly compensate the investor for his efficient sacrifices in the service of the public.

II

In applying depreciation calculations to properties, the engineers or accountants have developed two fundamental methods. One is called depreciation by observation of condition and the other depreciation by estimated remainder of life.

Depreciation by observation means merely that some one fully acquainted with all the parts or items of property similar to the one under consideration shall view the property carefully and estimate

how much it has been damaged by use and by deterioration due to natural causes and then in most cases shall estimate the loss in value due to progress in the art since the installation of the equipment and shall also estimate loss in value due to the changing conditions or prospective change of conditions in the services demanded.

Under the observation method it is supposed that the results are arrived at merely by judgment and with no definite rules or mathematical calculation. It will be seen later that the elements involved in such exercises of judgment are exactly similar to elements which are mathematically taken into consideration under the method of depreciating by calculated remainder of life, but it is also evident that, in establishing depreciation by observation, widely different results might be obtained by different men, each sincere in his attempt to reach an honest conclusion. Even the state of digestion of the valuator, the weather, or any thing which might influence his temperament could in all seriousness have a material effect on his opinion of the state of the property, and his friendship for or opposition to the owners of the property could have and probably would have a very marked effect on his conclusions without any conscious dishonesty or insincerity on his part.

The second method of depreciation by calculation of remainder of life is merely a refinement of the observation method and introduces mathematical steps which in themselves are correct but which unfortunately are based upon data whose correctness cannot be established in most cases. This method, therefore, on account of the speciousness of correct calculations based on unreliable data is dangerous and has in all probability caused a great amount of injustice to be accepted by the victims because the very speciousness of the method has persuaded them that the results were logical.

The controlling factor in depreciation by the remainder of life method is the estimated duration of life assigned to the item of equipment upon which the depreciation is to be calculated. With the exception of very few of the items of equipment of public service properties (especially the municipal utilities) there does not exist any correct collection of data which will give reliable periods of useful life to the different items of equipment used. There may be more or less correct collections of data on such equipment as poles or railroad ties, which will give an approximately correct average life on this kind of equipment, and it might be that on these items,

where the forces of nature are the principal destructive agents, the average life will not in most cases vary greatly as between different properties. Even this statement is, however, somewhat broad and unreliable and a correct application of an average would depend considerably upon the size of the property. If we were calculating depreciation on all the poles in the United States or on a company whose property was scattered throughout the country, the average life might bring a just result. But on the other hand, if we were calculating on a small property where local soil conditions or other natural destructive forces were in any way peculiar, our results would not be correct.

Departing from such equipment as poles and ties it can be said that the life of similar items of equipment of each particular property may vary to such an extent as to make the acceptance of average life, even if correctly obtained, a very reckless proceeding in determining the amount of property upon which investors should receive a reasonable return. The use of the property, the adequacy of its maintenance, the changes in local conditions as to demands for service and many other elements will so influence the life of equipment in any one case that its relationship to any average will be materially distorted.

It has been the custom of engineers and of some commissions to publish life tables in their reports setting forth the estimated life of each particular class of equipment. It may be noticed that nearly all of these tables very closely agree in the estimated life of the different classes of property, and to the layman or even to the superficial technical man, this agreement tends to cause the acceptance of the figures as basic data without much question. The facts are that, on such items as buildings, stationary engines, auxiliaries, piping, etc., there exist no reliable data to base an average estimate of life. On other items such as rails, cars, etc., where the elements of use and maintenance are vital to the life, there can also be no correctly calculated life which will apply throughout the whole class of equipment. On such items as underground conduit or even water and gas piping, time has not yet been long enough to establish life definitely for even local properties. Added to this is the fact that the forces of obsolescense and inadequacy are not capable of calculation. The fact that the before-mentioned tables of

life of equipment do agree very closely is due to nothing except that the first man made a guess and the rest having very little ground upon which to base a difference have followed him very closely.

Depreciation by the method of the remainder of life has been followed out in a number of different systems. The most obvious method, and the simplest, is called the straight line system. This means that the estimated life is taken, say at twenty years and each year the item is supposed to have lost one-twentieth of its original cost or value. Another system is called the sinking fund system by which an estimated life is taken and the property is supposed to have lost each year that amount in value which, if set aside at compound interest, would, at the end of the estimated life, amount to a fund equal to the original cost or value. It is seen by this method that the value of the property is determined to a great extent by the rate of interest at which the depreciation fund may in the future be invested. It is evident that a considerable difference between the present depreciated value of a property might rest on whether the prophesied rate of return on the fund would be 3 per cent or 6 per cent. This system, while somewhat logical for establishing depreciation charges for accounting, is entirely illogical and wholly speculative when used to establish a substitute for present value.

Another system of depreciation by the remainder of life method is sometimes called the diminishing value system. By this method the property is diminished in each year by a fixed percentage of the remainder of value after the deductions for depreciation for preceding years have been made from the principal. This method is very seldom used and is merely an accountant's device for setting up general depreciation charges and, as it has no rational place in establishing a so-called depreciated value of the property as a whole, it need not be dwelt upon here.

In preceding paragraphs it has been the writer's principal aim to show the extreme unreliability of depreciation calculations, even if it were conceded that it were proper to apply depreciation deductions to arrive at an amount upon which reasonable returns should be based. This unreliability of basic data should in itself demonstrate the recklessness with which such calculations have been applied in depriving investors of property by depriving them of the earnings of capital placed in good faith in the service of the public.

III

The general idea of the depreciation of a property as accepted by the layman and as seemingly accepted by many courts and some commissions is that a public service property begins with a value as a whole of 100 per cent and then gradually sinks to zero. This supposition may be theoretically true of one item of property. A boiler for instance begins with a value equal to its cost and of course at the end of its life, whenever that may be, there remains only the scrap or second-hand value.

This steady deterioration in value (measured by remainder of life) from 100 per cent to scrap value may be true of one item of equipment, but it is not true of a whole property. If a property composed of numerous units were installed all at one time, the theoretical depreciation by remainder of life, if it could be correctly calculated, would show that the property as a whole could not reach zero or the composite scrap value until a period of years have lapsed equal to the least common multiple of all the lives correctly estimated for each different class of equipment. In even the simplest property it is evident that this period would theoretically stretch out into centuries. It is assumed in this statement that we are speaking of the composite life of a property and that each particular item of equipment is renewed at the end of its life. If it were not renewed and were a vital part, the value of the whole property would be immediately destroyed by its non-replacement and under these conditions the calculation is correct that the composite life of the whole plant will not be ended until such time as the ends of the renewed lives of all the items of equipment coincide, which will be as stated, at the end of that period which is the least common multiple of all the lives.

The above statement is true of a property built all at one time. But immediately that we install equipment at different times with any two installations having the same life we find that the termination of all the lives of all the equipment will, theoretically, never coincide, and that therefore, the composite value of the property based upon the remainder of life will never reach zero nor the scrap value and that the curve of remainder of life will never ascend to 100 per cent. The curve of the composite remainder of life will in fact describe a series of cycles, each cycle representing the least common

multiple of all the lives. Under ordinary conditions of establishment of utility properties there are successive installations and a constant growth in the property so that, in any property of sufficient size, the curve of the composite remainder of life will eventually tend toward a level halfway between 100 per cent and scrap value.

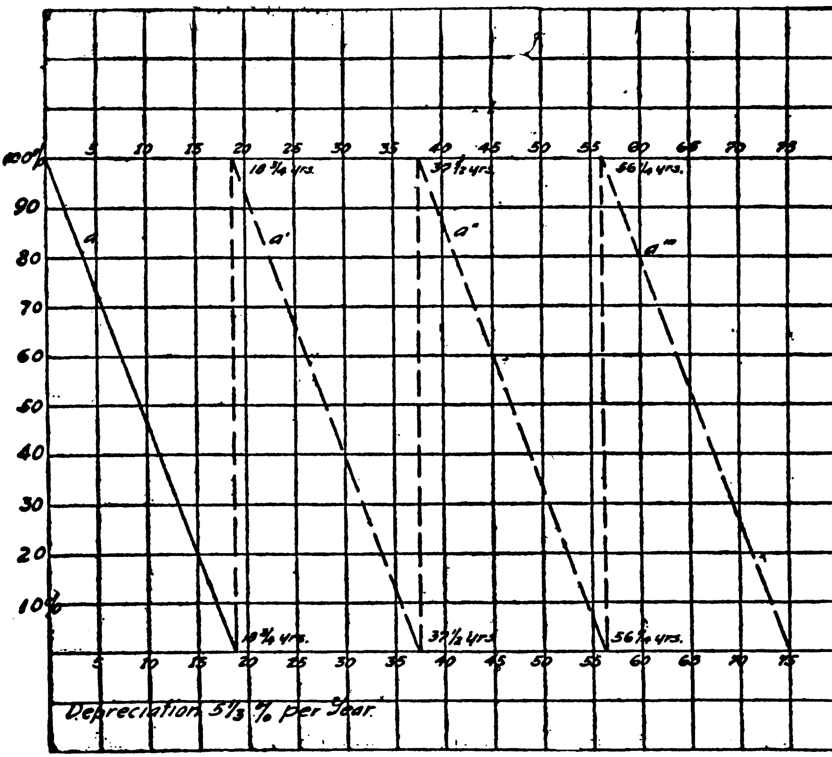

Fig. 1. The line a represents one item of equipment with a life of 18¾ years. The broken lines a' a'' a''' represent successive renewals of a. Years are indicated by figures in horizontal lines at top and bottom of diagram.

The foregoing truths and principles pertaining to such composite lives are illustrated in the following diagrams.

Figure 1 shows the remainder of life curve for one item of equipment. It is this curve that is fallaciously accepted by the laymen as the true curve of the life of a property.

Figure 2 shows the effect on the composite remainder of life of even such a simple condition as having only two items of equipment, of equal costs, one with a fifteen-year life and the other with a twenty-five-year life.

It will be seen that the heavy line which represents the mathematical composite life of the two items of equipment or their renewals

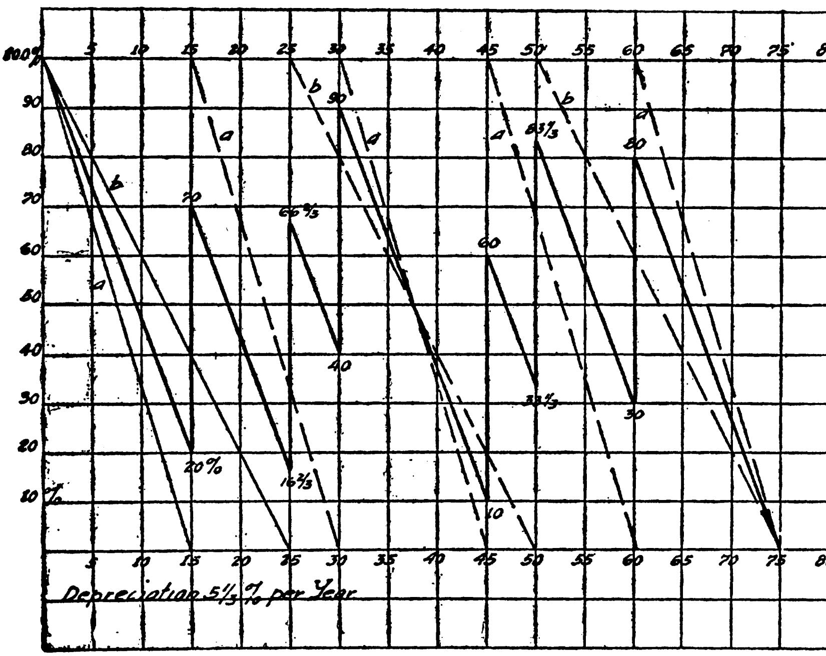

Fig. 2. The lines a and b represent installations of equipment having lines of 15 and 25 years respectively. The broken lines represent renewals of a and b. The heavy line represents the composite theoretical remainder of life curve of a and b. Figures at top and bottom of diagram are years.

does not go straight from 100 per cent to zero, but influenced by successive renewals it takes a course of irregular oscillations across the 50 per cent line, finally reaching zero at the end of seventy-five years when the ends of life of the renewed two items of equipment coincide. Seventy-five years is the least common multiple of fifteen and twenty-five.

Figure 3 shows the effect on the composite remainder of life curve of introducing installations of equipment at different times. The elements in the diagram represent four items of equipment, two having fifteen-year life and two having twenty-five-year life, one item of each life being installed at the beginning of the plant and the other ten years thereafter. It will be seen that the effect of this very simple installation made at two different periods is to bring the composite remainder of life curve into closer correspondence to the 50 per cent level. The composite remainder of life curve can under these circumstances never reach zero and never go to the 100 per cent but will follow cycles of the least common multiple of all the lives.

From figure 1 to figure 3 we trace the effect of added equipment installed at different times and of different lives under the simplest theoretical condition. When we take into consideration the innumerable items of a large plant and the steady leveling of yearly investments which may take place in a large property and the further factor of the varying values of the different items having different lives, we will see that, in a large piecemeal built property, the composite remainder of life curve will eventually closely approximate the results shown in figure 4, where we have a composite remainder of life curve straightened out in close correspondence with a line halfway between scrap and 100 per cent. This is theoretically the permanent state of a large piecemeal-built and well-maintained property.

To illustrate how closely this purely theoretical remainder of life curve will approximate a similar application of the theoretical estimates of life to a real property, there is shown in figure 5 a carefully calculated composite remainder of life line for a large street railway property in actual existence. This curve is built up upon inventory, cost data and estimated life applied to each class of equipment entering into the property.

In this curve it is seen that the composite remainder of life line at times rises nearly 10 per cent above the normal remainder of life line and at times falls nearly 10 per cent below. But this is only a very slight variation, all things considered. It is probable that, if the property is well managed, these variations would tend to disappear owing to the effort to distribute expenditure for renewal as evenly as possible each year. The result of the study of these curves

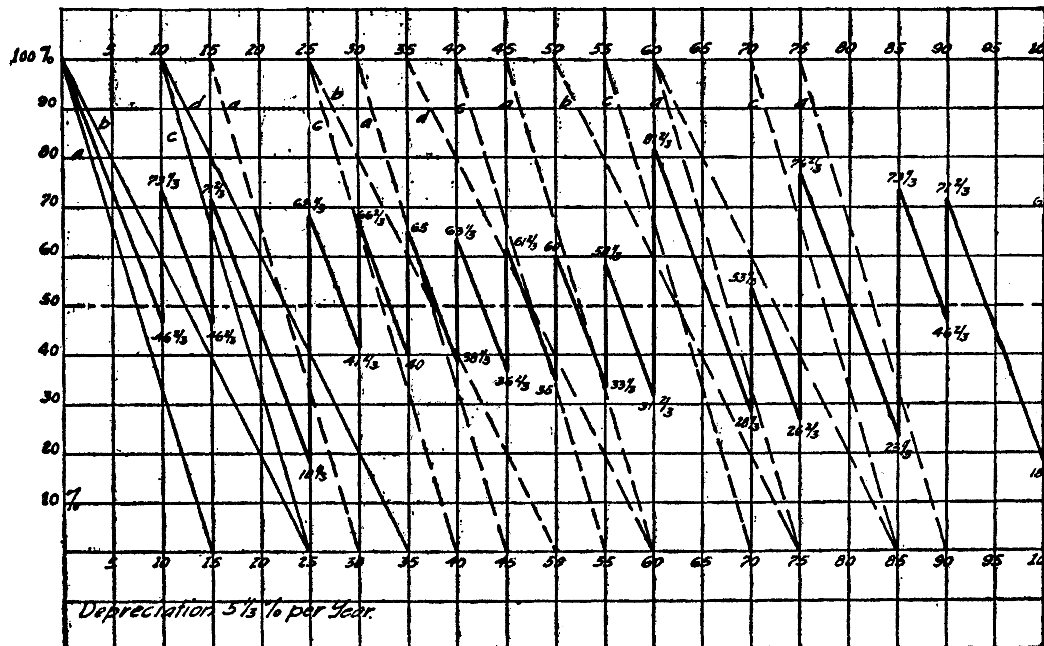

Fig. 3. Lines a, b, c and d represent installations of equipment. Broken lines represent renewals of a, b, c and d. The heavy line represents the composite theoretical remainder of life curve of a, b, c and d. Figures at top and bottom of diagram are years.

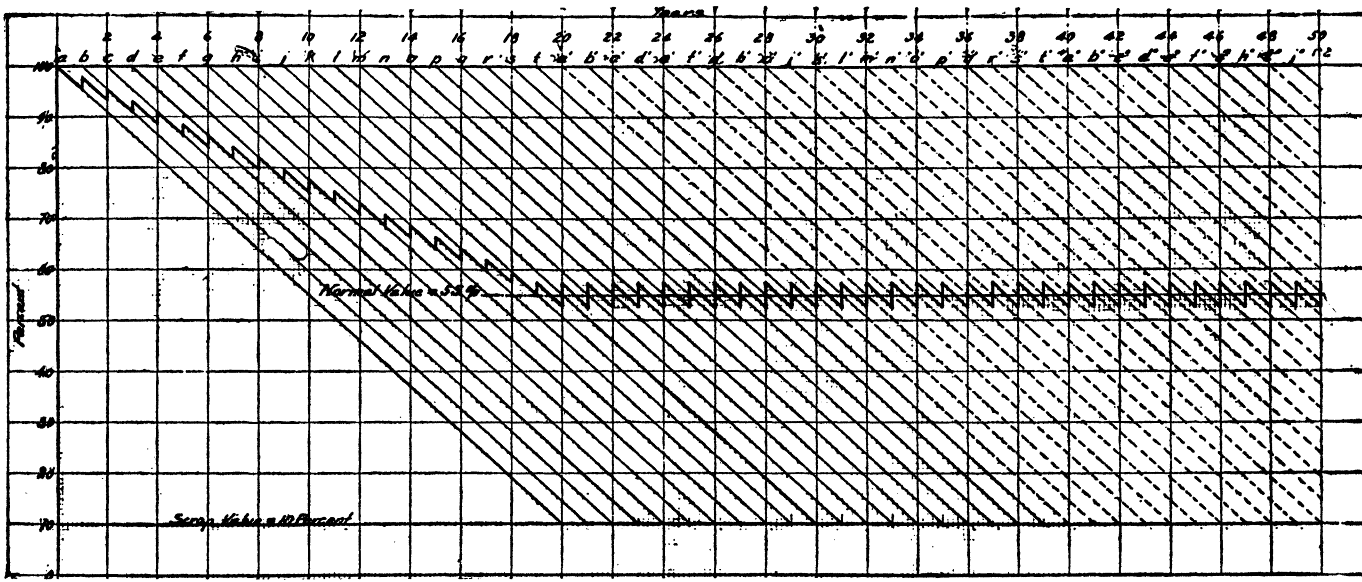

Fig. 4. Lines a to t represent equal annual installments of equipments. Broken lines a' to t', etc., represent renewals.

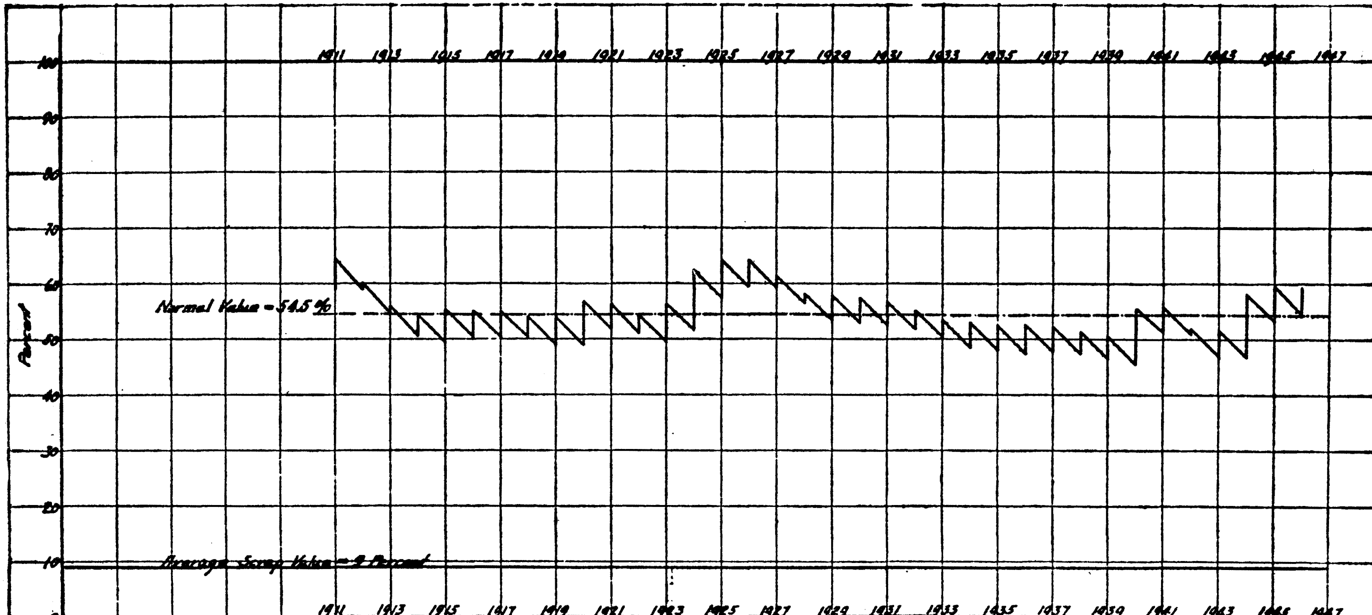

Fig. 5. Total composite theoretical remainder of life curve of the depreciable property of the United Railways Company of St. Louis.

goes to show that large piecemeal-built properties attain a normal condition of remainder of life which approximates the line halfway between scrap value and 100 per cent. While the above conclusions and illustrations have been the result of using the straight line system only, practically similar results will follow the use of the sinking fund system. In this paper there is room for considering only straight line depreciation.

It is not contended that the level remainder of life line or the permanent composite age of the property will continue if additions or extensions are made. In that case the composite curve will ascend toward the 100 per cent level in proportion to the magnitude of the additions and extensions and will then tend to return to the normal level. But this circumstance does not in the least affect the conclusions which the writer wishes to draw from the fact that the present existing property of an enterprise which has gone through the adjustment period has a comparatively level and permanent state of composite age or remainder of life.

Conclusions

From part I we see that any use of depreciation to obtain the capital amount upon which to base returns is merely a useless attempt to establish a present exchange or market value where the only vital factor of a true exchange value, namely the return, is of necessity in a rate case left out of the calculation.

From part II it is shown that, even if it were proper to depreciate, the calculations on estimated life are unreliable in the extreme.

From part III the conclusion is reached that piecemeal-built properties, if maintained, do not come to an end by depreciation but reach an approximately permanent state in regard to composite age and in that state are the most efficient as to economy of operation (maintenance and replacement considered). Any attempt to raise the curve must be done by throwing away property not yet having served its useful life. And if we assume as we ought, that the life of a piece of equipment ends when it begins to give poor service, then we see that the owners of the property are, by maintaining it on the normal theoretical age line, performing their duty toward the consumer by giving service as good if not better than from a new plant.

No one can be so foolish as to assume that investors can construct or maintain a plant which will remain new. But they can maintain it so as to give a service practically as good as from a new plant. The fact is that they really pay their full investment in plant for the normal and permanent state of the plant at which it will give good service continually, and if for any reason a depreciated value should be assigned as the capital to be earned on when the plant is in a permanent state and giving good service, then the amount of such deduction for so-called depreciation might well be called a cost of establishing business and therefore a legitimate part of "fair value."

A study of any theoretical depreciation curve will show that, if the theoretical depreciation charges have been made from the installation of each item, the accumulation in the depreciation fund will always equal the amount of depreciation, i.e., the sum of the depreciated value, and the accumulated fund will always equal the original investment, and, when on account of the straightening out of the curve along the normal age line there cease to be any wide fluctuations for large renewal at any one time, then a great part of the fund will be a needless accumulation as it can never be used for replacement or renewal.

The stock argument of the advocates of allowing earnings only on a depreciated investment is that a large depreciation fund is necessary and that if the company has not laid it by it is evidence that the amount of it has been wrongfully diverted as profits into the pockets of the owners. It has been shown by the preceding diagrams that, in the larger properties at least, the accumulation of a depreciation fund on the basis of estimated life would have been a useless charge upon the consumer or upon the investor as the case may be. So to assume arbitrarily that this theoretical fund should have been set aside by the owners, and if not set aside to penalize them in the earning power of a normal property to the amount of the determined hypothetical fund, is unreasonable in the extreme. Where there could have been no such fund set up in the past without depriving the investor of all or the greater part of the returns as is generally the case, the injustice is evident on its face and where profits have been such as to have enabled the setting up of the fund in addition to the payment of returns the device of depreciating (the fund being needless) becomes merely a means of depriving the investors of past profits which may or may not have been excessive.

Notwithstanding the many respectable authorities who uphold the practice of deduction from earning power on account of theoretical depreciation there appear to be equally respectable reasons for assuming that present exchange value or any attempt at it is not the proper base for returns in rate regulation and that the proper amount to establish as a "fair value" is the capital efficiently placed in the service of the public in order to produce a plant and business in its normal and permanent state.